FISHERY RESEARCH

PROJECT 5—LAKE AND RESERVOIR RESEARCH

Grant F-73-R-30

Report Period July 1, 2009 to June 30, 2010

Kevin A. Meyer, Principal Fisheries Research Biologist

Arthur E. Butts, Regional Fisheries Biologist

F. Steven Elle, Senior Fisheries Technician

James A. Lamansky, Jr., Senior Fisheries Research Biologist

and

Elizabeth R. J. M. Mamer, Data Coordinator

IDFG Report Number 10-12
November 2010

ANNUAL PERFORMANCE REPORT

July 1, 2009 to June 30, 2010

Grant #F-73-R-30

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Subproject 3: Angler Tag Reporting Evaluations

By

Kevin A. Meyer

Arthur E. Butts

F. Steven Elle

James A. Lamansky, Jr.

and

Elizabeth R. J. M. Mamer

Idaho Department of Fish and Game
600 South Walnut Street
P.O. Box 25
Boise, ID 83707

IDFG Report Number 10-12
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ANNUAL PERFORMANCE REPORT

SUBPROJECT 3: ANGLER TAG REPORTING EVALUATIONS

State of: Idaho Grant No.: F-73-R-29 Fishery Research

Project No.: 5 Title: Lake and Reservoir Research

Subproject #3: Angler Tag Reporting Evaluations

Contract Period: July 1, 2009 to June 30, 2010

ABSTRACT

Estimating fish harvest from angler returns of tagged fish requires knowledge of the reporting rate. From 2006 to 2009, we tagged and released 27,149 fish (comprised of 11 species) in 48 water bodies across Idaho to assess angler tag reporting rates and estimate angler exploitation. We used T-bar anchor tags using the high-reward tag method to estimate tag reporting rates, where tags with various dollar values ($0, $10, $50, $100, and $200) were released. To date 5,231 tags have been reported by anglers. Non-reward reporting rate averaged 54.6 ± 1.6% across all years and species and varied substantially by species but not across time; assuming a reporting rate of 100% for $200 tags, reporting rates were 70.2 ± 2.2% for $10, 92.2 ± 6.5% for $50, and 99.7 ± 9.6% for $100. In general, non-reward tag reporting rate was highest for harvest-oriented coolwater and warmwater fisheries such as walleye *Sander vitreus* (68.3 ± 8.9%), yellow perch *Perca flavescens* (58.5 ± 12.4%), and crappie *Pomoxis* spp. (59.7 ± 3.3%); tag reporting rate was lower for largemouth bass *Micropterus salmoides* (39.2 ± 5.2%), smallmouth bass *M. dolomieui* (54.6 ± 2.8%), and hatchery trout *Oncorhynchus* spp. (49.2 ± 3.3%). There was no evidence that our study design violated the assumption of independence of tag returns. This was evidenced by the fact that non-reward tag reporting rate was not substantially higher for households reporting multiple tags compared to those only reporting one tag, nor for anglers reporting both non-reward and reward tags compared to those reporting only one or the other. Tag loss, estimated by double tagging about one-half of the fish, averaged 7.3 and 19.7% in year one and year two, respectively. Short-term (7-day) mortality averaged 1.5% for wild fish; for hatchery fish held 22-33 days, mortality averaged 1.1%, but unlike for wild fish, this estimate was not corrected for mortality of untagged fish. We developed 80 estimates of annual exploitation, which were corrected for tag reporting rates, tag loss, and tagging mortality; exploitation averaged 18.1% and ranged from zero to 78.8%. Exploitation was highest for crappie at a mean of 30.1% (range 13.0 – 54.5) and smallmouth bass at a mean of 23.6% (range 12.2 – 35.0), and lowest and most variable for hatchery trout at a mean of 15.7% (range 0-78.7%). Our results suggest that anglers report about half the T-bar anchor tags they encounter, much higher than previously assumed. The reporting rates from this study should be used statewide to estimate harvest for Idaho fisheries, but reporting rates may change over time and should be revisited regularly (e.g., every 1-3 years) to assess changes.

Authors:

Kevin A. Meyer, Principal Fisheries Research Biologist
Arthur E. Butts, Regional Fisheries Biologist
F. Steven Elle, Senior Fisheries Technician
James A. Lamansky, Jr., Senior Fisheries Research Biologist
Elizabeth R. J. M. Mamer, Data Coordinator

INTRODUCTION

Angler exploitation can have an important influence on the structure of sport fish communities through effects on recruitment, mortality, and growth. Even when it is negligible, knowing the exploitation rate of a fishery is often useful for fishery managers to address public concerns and to track changes over time. However, estimating exploitation can be extremely difficult and labor intensive (Miranda et al. 2002), and techniques to estimate exploitation include numerous assumptions that, when violated, introduce a great deal of uncertainty to estimates.

The most common technique for estimating exploitation consists of releasing a known number of marked fish with tags and relying on angler tag returns to estimate the proportion harvested (Pollock et al. 2001). This method requires that the actual tag reporting rate be estimated, which can be problematic because the number of tags encountered by anglers and not reported is typically unknown. The willingness of an angler to report a tag from a harvested fish is therefore a critical facet of an exploitation study that uses voluntary tag returns, although it is generally the variable with the highest uncertainty. Methods used to estimate tag reporting rates include: 1) estimating the reporting rate from tagging data alone when natural mortality is assumed to be constant (Youngs 1974; Hoenig et al. 1998); 2) using high-reward tagging programs (Pollock et al. 2001); 3) surreptitiously planting tags into the creel of anglers (Green et al. 1983); and 4) using angler surveys (Pollock et al. 1991). Estimating reporting rates solely from tagging data generally yields imprecise estimates and requires multiple years or more than one tagging event each year (Hearn et al. 1998; Pollock et al. 2001). Using the planted tag method, where tags are secretly planted in fish while creel clerks examine the creel, is problematic because of the need for secrecy, which may cause situations of confusion, distrust, or other biases among recreational anglers. Angler surveys, where a clerk monitors angler creel at an access point, often require a great deal of sampling effort to encounter tags, and anglers may assume that a tag has already been reported after the creel was examined, thus biasing reporting rate estimates. Consequently, the most accurate and convenient method of estimating angler reporting rate is the reward tag method, where both non-reward and high reward tags are released, and the non-reward tag reporting rate is estimated as the relative recovery rate of non-reward tags to that of high-reward tags (Nichols et al. 1991; Pollock et al. 2001).

The primary assumption of the high-reward methodology is that the high reward is sufficient incentive for anglers to report 100% of the high-reward tags they encounter. Numerous investigations, conducted over a broad spectrum of species, systems, and geographic ranges, have estimated the reward amount needed to elicit a 100% response rate (Conroy and Blandin 1984; Weaver and England 1986; Eder 1990; Haas 1990; Murphy and Taylor 1991; Nichols et al. 1991; Jenkins et al. 2000; Schultz and Robinson 2002). These studies have had a number of limitations, such as small sample sizes, assuming the high-reward tags achieved a 100% reporting rate, or violations of other assumptions. In addition, many studies used various combinations of either non-monetary rewards (e.g., hats, shirts, patches, beer) or lottery-type programs where one or more large rewards were randomly chosen at the end of the study from all the reported tags, while the remaining tags received either no reward or a minimal value reward. While there is evidence that these types of reward programs increase the tag reporting rate, it is difficult to assess the degree that reporting rates increased (see review in Pollock et al. 2001). Other factors that could affect tag reporting rates include whether an angler is turning in only one tag or multiple tags, and whether having a reward tag to turn in affects the rate of non-reward tag returns. An angler's general awareness of the tagging program, the ease of reporting tags, and whether the fishery is harvest- or catch-

and-release-oriented may also affect an angler's willingness to remove and return tags, as could the species being investigated.

Tag reporting rates reported within the fisheries literature are quite variable and, as such, are unreliable for general use in exploitation estimates elsewhere. Estimates of tag reporting rates include 31-61% for three warmwater species in a California reservoir (Rawstron 1971), 18-52% for rainbow trout *Oncorhynchus mykiss* in an Oregon stream (Moring 1980), 15-36% for various saltwater species in Texas bays (Green et al. 1983), 67-92% for crappie *Pomoxis spp.* in Missouri reservoirs (Colvin 1991), 29-71% for crappie in Georgia reservoirs (Larson et al. 1991), 27-85% for sauger *Sander canadensis* in Alabama (Maceina et al. 1998), 24-62% for crappie in five southeastern U.S. reservoirs (Miranda et al. 2002), and 20-54% in Kansas reservoirs (Schultz and Robinson 2002).

To date, one of the most robust studies that estimated tag reporting rates is that of Nichols et al. (1991), where variable reward-response curves were developed for reporting of bands on mallard ducks *Anas platyrhynchus*. This study reported a 32% reporting rate for non-reward bands and determined that the reward amount needed to generate a 100% reporting rate was approximately $100 (in 1989 US dollars). This information has since been used in fisheries investigations (e.g., Zale and Bain 1994; Kozfkay and Megargle 2002), but the uncertainty of applying tag reporting rates derived from duck hunters to fisheries studies is problematic. Thus, we sought to develop such response curves for Idaho anglers pursuing various fish species at assess the range and consistency in tag reporting rates.

OBJECTIVES

1. To learn whether tag reporting rates are consistent across species, years, water types, and geographical areas to assess implications for fisheries management in Idaho.

2. To learn whether non-reward tag reporting rate is affected by a) whether the non-reward tag was attached to a fish also containing a reward tag, b) whether the angler reported both reward and non-reward tags rather than one type or the other, and c) whether more than one tag is reported from the same person or household.

3. To learn the degree with which exploitation rates vary for various species in numerous waters across Idaho.

METHODS

From 2006 to 2009, Idaho Department of Fish and Game (IDFG) personnel tagged 27,149 fish distributed across 48 statewide waters (Table 1) with Floy® FD-68BC T-bar anchor tags. Tags were fluorescent orange, 70 mm in total length (51 mm of tubing), and were treated with algaecide. Tags were labeled on two sides, with one side stating the agency and phone number (i.e., "IDFG 1-866-258-0338") and the other side listing a tag number and reward amount if applicable. A toll-free automated telephone hotline and website were established through which anglers could report tags, although some tags were mailed in or dropped off at IDFG offices. In addition, informational posters and stickers were distributed to IDFG license vendors, regional offices, and sporting goods stores to publicize the tagging efforts, explain how the information was being used, and provide tag return instructions. No other information was provided to anglers, and individual water bodies were not signed, so that site-specific

exploitation estimates in the future would not require labor-intensive sign maintenance activity at each site that tags are released.

The primary species tagged were white crappie *Pomoxis annularis* and black crappie *P. nigromaculatus*, largemouth bass *Micropterus salmoides*, smallmouth bass *M. dolomieui*, and hatchery and wild rainbow trout (Table 1). White crappie and black crappie often occur in sympatry in Idaho waters, and anglers generally do not distinguish between the species, so they were lumped during analyses. Other species tagged in the study were yellow perch *Perca flavescens*, walleye *Sander vitreus*, channel catfish *Ictalurus punctatus*, lake trout *Salvelinus namaycush*, brook trout *S. fontinalis*, cutthroat trout *O. clarkii*, and rainbow x cutthroat hybrids.

Wild fish and holdover hatchery fish were typically collected using a boat-mounted electrofisher (settings of 300-600 volts DC, ~60 Hz, and 4-8 millisecond pulse width for ~40% duty cycle and an output of about 1-5 amps). During electrofishing, fish were captured and placed in a live well in small quantities until they were tagged and released near where the fish were captured to ensure good distribution of tags. Wild trout were also captured at weirs. Hatchery trout that were used in this study were netted out of the raceway, anesthetized, tagged, and held in a pen within the raceway until stocking. All species were tagged below the dorsal fin following the recommendations of Guy et al. (1996). To reduce the rate of tagging mortality, individual fish were judged up to the point of release as to whether they were unfit for our study due to visible signs of stress from the capture and handling procedures (Ryan 1990; Vreeland 1990; Nielsen 1992). Tagged fish were always of harvestable size based on angling regulations and desirability.

Tags consisted of five reward levels: $0 (also referred to as non-reward), $10, $50, $100, and $200, which were generally applied at rates of 76%, 8%, 8%, 4%, and 4%, respectively (Table 11). The high-reward values were based on the finding by Nichols et al. (1991) that approximately $100 US was needed to generate a 100% reporting rate, which in 2006 dollars translated to $163. Using $100 and $200 for our study allowed us to bound the value from Nichols et al. (1991) once translated to current dollar value.

Angler tag reporting rate (λ) was estimated using the relative reporting rate of non-reward tags to that of high-reward tags (Pollock et al. 2001):

$$\lambda = \frac{R_r / R_t}{N_r / N_t}$$

where R_t and R_r are the number of standard tags released and reported, respectively, and N_t and N_r are the number of high-reward tags released and reported. Reporting rates were similarly estimated for tags with other dollar values. Variance was calculated according to Henny and Burnham (1976):

$$\mathrm{var}(\lambda) = \left(\frac{1}{R_r} + \left(\frac{\lambda}{R_r} \right)^2 \bullet \left(\frac{R_t}{N_t} \right)^2 \bullet N_r \right) \bullet \lambda^2$$

from which 90% confidence intervals (CIs) were calculated.

To estimate tag loss, nearly all reward-tagged fish and about 1/3 of the non-reward-tagged fish were double tagged with an additional (secondary) non-reward tag, for a total of about 48% of the tagged fish being double tagged. Tag loss (Tag_l) was estimated as the number of double-tagged fish for which only a single tag was reported, divided by twice the total number of double-tagged fish reported, whether by one or both tags. Sample size was usually not adequate to estimate tag loss at each water body, so data were pooled to develop a tag loss estimate grouped by species. Variance was calculated according to the formula of Fleiss (1981):

$$pq / n$$

where p is the numerator divided by the denominator from the tag loss equation, q is equal to (1-p), and n is the denominator. From this variance estimate, 90% CIs were calculated. After determining that these secondary non-reward tags were returned at roughly the same rate as the primary non-reward tags, they were not used when calculating tag reporting rates in order to simplify our analyses.

To estimate tagging mortality (Tag_m), we captured wild smallmouth bass, largemouth bass, crappie, and trout at several water bodies and held them in 1 m x 1 m x 1 m wire-mesh cages sunk to the bottom in 2-10 meters of water. Half of the fish were tagged while the other half were held without tagging. Short-term mortality was estimated for tagged and untagged fish by calculating the proportion of fish alive one day and seven days after initial capture. For hatchery trout catchables, short-term mortality was estimated by tagging fish in the raceways and holding them in 1.5 m x 1.5 m x 3.0 m pens for 22 to 33 days.

The annual unadjusted exploitation rate (u) was calculated as the number of non-reward tagged fish reported as harvested within one year of tagging, divided by the number of fish released with non-reward tags. Annual adjusted exploitation rate (u') incorporated angler tag reporting rate, tag loss, and tag mortality, and was estimated using the following formula:

$$u' = \frac{u}{\lambda(1 - Tag_l)(1 - Tag_m)}$$

where the terms are defined as before. Variance for the denominator in the above equation was estimated using the approximate formula for the variance of a product in Yates (1953):

$$s^2_{x_1 x_2} = x_1^2 \cdot s^2_{x_2} + x_2^2 \cdot s^2_{x1}$$

where $s^2_{x_1 x_2}$ is the variance of the product, x_1 and x_2 are independent estimates being multiplied together, and s^2_{x1} and $s^2_{x_2}$ are their respective variances. Variance for u' was calculated using the approximate formula for the variance of a ratio, also in Yates (1953):

$$s^2\left(\frac{x_1}{x_2}\right) = \left(\frac{x_1}{x_2}\right)^2 \bullet \left(\frac{s^2_{x_1}}{x_1^2} + \frac{s^2_{x2}}{x_2^2}\right)$$

from which 90% CIs were derived. At water bodies where less than two high-reward tags were reported, and where high-reward tags were not released, we used the weighted mean reporting

rate for the appropriate species to calculate adjusted exploitation rates. Estimates of variance and 90% CIs were calculated as before.

Most current freshwater fisheries have a variable component of anglers with a voluntary catch and release ethic (Quinn 1996). Consequently, estimates of the rate of exploitation do not necessarily characterize the utilization of fish by anglers. To account for fish released in addition to classical annual exploitation rate, we calculated the amount of 'use' a tagged group of fish provided anglers. 'Use' was calculated by substituting tags reported as 'harvested' with tags reported as caught, regardless of harvest or calendar year of the catch.

We evaluated whether our study design violated the assumption of independence of tag returns, such as might happen if anglers were returning batches of tags. We could not calculate reporting rates directly for this assessment because that would require knowledge of the number of tags released to each of two groups, such as anglers reporting a batch of tags and anglers reporting one tag; no such separation of tag releases could be made because tags were released to all anglers together. Instead, we used a χ^2 test to assess the percentage of tags reported for each dollar amount between groups, testing whether reported tags were proportionally different for anglers who 1) reported more than one tag from the same household (observed) compared to anglers reporting only one tag (expected), and 2) reported both non-reward and reward tags (observed) compared to anglers reporting only one or the other (expected).

RESULTS

To date, a total of 5,231 tags have been reported by anglers (Table 1). Tags have been reported primarily using the tag return phone hotline (mean = 53%) or website (36%; Table 2). Over the four years of the study, the proportion of tags reported via the phone hotline has decreased from 62% to 48% whereas tags reported via the website have increased from 22% to 44%. As of 19 March 2011, we have awarded $136,360 in rewards.

Reporting rates increased as dollar amount increased (Figure 1, Table 3). Assuming 100% reporting rates for $200 dollar tags and pooling tags across all years and species, mean weighted reporting rates were 54.5 ± 1.6% for non-reward tags, 70.2 ± 2.2% for $10 tags, 92.2 ± 6.5% for $50 tags, and 99.7 ± 9.6% for $100 tags. Using $100 and $200 returns combined as high-reward tags (to improve sample size of high reward returns), our mean weighted reporting rate for non-reward tags was virtually unchanged, at 54.6 ± 1.6%.

There did not appear to be any consistent pattern to differences in non-reward tag reporting rates between years (Table 3). For example, crappie and smallmouth bass reporting rates were both highest in the initial years of tagging and lowest in the last year. For hatchery trout, returns in year one were highest. Non-reward tag reporting rate for all species combined was 53, 56, 50, and 56% from 2006 to 2009.

Non-reward tag reporting rate was highest for harvest-oriented coolwater and warmwater fisheries (Table 3), such as walleye (68.3 ± 8.9%), yellow perch (58.5 ± 12.4%), and crappie (59.7 ± 3.3%). Tag reporting rate was lower for largemouth bass (39.2 ± 5.2%), smallmouth bass (54.6 ± 2.8%), and hatchery trout (49.2 ± 3.3%). Site-specific estimates of non-reward tag reporting rate varied substantially, from a low of about 21% to a high of over 100%, but most estimates (78%) ranged from 35-66% (Table 1).

Tag loss varied by species, with loss rates being lowest for crappie and yellow perch and highest for bass and walleye (Table 4). Tag loss in the second year that tagged fish were at large was on average 2.5 times higher than in year one.

Tagging mortality was generally zero or very low (i.e., <5%) for all estimates (Table 5). For fish where short-term (i.e., 7-day) mortality was monitored for both tagged and untagged fish, tagged fish mortality was on average about 1% higher than for untagged fish. We therefore assumed tagging mortality was very low but not zero, and used 3% as an estimate of that mortality (with no variance associated with this 'estimate').

Taking into account angler reporting rate, tag loss, and tagging mortality, adjusted exploitation ranged from a low of 0% in four instances to a high of 78.8% for hatchery rainbow trout in Kelso Lake (Table 1). Exploitation on average was highest for crappie at a mean of 30.1% (range 13.0-54.5%) and smallmouth bass at a mean of 23.6% (range 12.2-35.0%), and lowest and most variable for hatchery trout at a mean of 15.7% (range 0-78.7%). Exploitation was also high for yellow perch (25.9%) and channel catfish (24.9%; Table 1).

Total rate of 'use' (i.e., the percent of tagged fish caught, regardless of harvest or calendar year) was on average 2.6 times higher than annual exploitation rates (Table 1). Fisheries that provided the highest rate of 'use' relative to harvest were those for largemouth bass ('use' was 3.3 times higher than annual harvest), wild trout (2.4 times higher), and smallmouth bass (2.3 times higher). The harvest-oriented fisheries such as hatchery trout (1.5 times higher) and crappie (1.6 times higher) provided lower rates of 'use' above and beyond the rate of annual harvest.

We found no evidence of a violation in the assumption of independence of tag returns, in that angler reporting rate was not affected by whether an angler was reporting both reward and non-reward tags versus anglers reporting only one or the other, or by whether an angler or household was turning in only one tag versus multiple tags (Figure 2). Non-reward and high reward tags made up 73.0% and 10.8%, respectively, of the tag returns for anglers who reported both reward and non-reward tags, compared to 67.7% and 11.8% for anglers reporting only one or the other; this difference was not statistically significant ($\chi^2 = 3.23$; $P = 0.07$). Similarly, non-reward and high reward tags made up 69.0% and 11.3% of the tags reported by anglers or households who reported multiple tags, compared to 72.9% and 10.9% for anglers or households who reported only one tag; this difference was also not statistically significant ($\chi^2 = 0.94$; $P = 0.33$).

DISCUSSION

Angler tag reporting rates across all water bodies and species in Idaho averaged about 55%, which is at the upper end of most values found in the fisheries literature. Previous estimates have ranged from a low of 15% to a high of 92%, but generally have been between 20 and 65% (Rawstron 1971; Moring 1980; Green et al. 1983; Colvin 1991; Larson et al. 1991; Maceina et al. 1998; Miranda et al. 2002; Schultz and Robinson 2002). Our average reporting rate was much higher than the estimated 32% for non-reward mallard duck band returns from Nichols et al. (1991), which has been used in fisheries studies in Idaho and elsewhere (e.g., Zale and Bain 1994; Kozfkay and Megargle 2002) due to the quality of the study design. However, with the same study design, other duck banding reporting rates and reporting rates for other studies of birds have varied widely as well, ranging from 38-71% in studies by Henny and Burnham (1976), Reeves (1979), Conroy and Blandin (1984), Nichols et al. (1995), and

Diefenbach et al. (2000). Taken collectively, these studies of birds had an average reporting rate of 44%, which is close to our average of 55%. The similarity in the mean and range of reporting rates between hunters and anglers is not surprising considering that they are frequently the same people. The variability is likely due to differences in clientele and angler groups frequenting the water body, angler satisfaction with the fishery and with fish management at the water body, geographical area of the state or country (Conroy and Blandin 1984; Nichols et al. 1995), and other potential factors. We believe the range of reporting rates in our study is probably representative of what should be expected for anglers in Idaho and should be used for future estimates of exploitation based on angler returns of non-reward tags.

Our results suggest that somewhere between $50 (92% estimated reporting rate) and $100 (100%) was needed to elicit the maximum reporting rate from anglers (Figure 1, Table 3). This agrees with Nichols et al. (1991) who also found an asymptote between $50 and $100 (1988 dollars) for mallard duck band returns, and with Taylor et al. (2006) who found an asymptote between $75 and $100 (1996 dollars) for tag returns of common snook *Centropomus undecimalis*. It appears that inflation in the last 20 years has not upwardly shifted the incentive needed to elicit the maximum reporting rate for tags in fisheries and wildlife studies.

In general, angler exploitation was highest for harvest-oriented coolwater and warmwater fisheries (Table 6), and compared similarly to typical harvest rates in North American fisheries. For example, crappie exploitation estimates of 13-55% in our study compare favorably to estimates of 40-68% for Larson et al. (1991) and 17-54% for Miranda et al. (2002). Baccante and Colby (1996) reviewed 46 reports on walleye exploitation and found an average of 21%, similar to our estimate of 18%. Miranda et al. (2002) similarly reviewed exploitation estimates from 32 studies of largemouth bass and found that harvest from 1953-2003 was parabolic shaped due to voluntary catch and release behavior since 1990; mean exploitation from 1990-2003 was 18%, similar to our estimate of 15% for largemouth bass. Surprisingly few estimates of exploitation for smallmouth bass are available in the literature, but our mean of 24% (range 12-35%) is slightly lower than results by Paragamian and Coble (1975; 34%), Marinac-Sanders and Coble (1981; 44%), and Paragamian (1984; 34%). This discrepancy for smallmouth bass is likely because the previous estimates were prior to when the above-mentioned voluntary catch and release ethic had captured bass anglers. For warmwater and coolwater fish populations, current exploitation by Idaho anglers was rarely (only 9 of 44 estimates) over 30%, and for wild trout populations averaged only 12%.

Exploitation of hatchery catchable trout averaged 17% and was≤ 8% for 10 of 22 estimates. With a statewide objective of returning 40% of stocked catchables to creel (IDFG 2006), our results indicate a substantial gap between IDFG objectives and observed harvest. This gap is smaller when considering that many anglers released the hatchery trout they caught; however, total ‘use’ only averaged 23%, still well short of the 40% mark. Too few estimates were from streams in our study to assess whether returns were equivalent between lentic and lotic environments. Dillon et al. (2000) found that unadjusted exploitation in 17 Idaho streams averaged 17.1%, which with our mean correction for hatchery trout of 49.2% reporting rate would translate to an average adjusted exploitation of 35%, compared to an average of 17% from 18 reservoirs in our study. This suggests that exploitation is much higher in Idaho streams than reservoirs. Our method of tagging hatchery catchables with anchor tags should be used throughout Idaho to assess rates of exploitation at additional water bodies in an effort to redirect stocking to water bodies with the highest returns to creel.

Non-reward tag reporting rates for coolwater and warmwater species were highest for crappie, yellow perch, and walleye, and were lowest for largemouth bass. This suggests that

anglers are more likely to report tags from fish they intend to harvest, and may find tag removal more of a nuisance if they plan to release the fish. This assertion is less supported by results from coldwater anglers, for which reporting rates was similar for wild trout anglers (who were much more likely to release their catch) and hatchery trout alike. Wild trout anglers may be more likely to be active participants in agency programs through angling groups (Gigliotti and Peyton 1993) and thus may be more likely to report tags from fish even if they are releasing them. Moring (1980) found that wild trout anglers had a slightly greater willingness to participate in mail responses of harvest than hatchery trout anglers.

Tag loss for the species in our study was generally lower than reported in most other studies using T-bar anchor tags. For example, one year tag loss was lower for crappie in our study (mean 3%) than for Larson et al. (1991; mean 18%) and Miranda et al. (2002; 47%), and was similarly was in our study for bass (mean 11%) compared to Tranquilli and Childers (1982; 56% after six months) and Hartman and Janney (2006; 57% after 13 months). Our estimate of 8% annual tag loss for hatchery trout was similar to Carline and Brynildson (1972; 4% after eight months), Mourning et al. (1994; 11% after four months) and Walsh and Winkelman (2004; 9% after six months). Often our cumulative tag loss after two years (e.g., 5% for crappie) was still lower than other published results for ≤1 year. It is important to note that for biologists who use tag returns from two consecutive years to estimate population metrics, such as second year harvest or total annual mortality, but fail to correct for increased tag loss in year two (e.g., Schultz and Robinson 2002), estimates will likely be biased high.

Our study results have some caveats, one being that in many instances, site-specific reporting rates were limited by the low number of returns of high-reward tags. For 14 of the 50 attempts to estimate site-specific reporting rate, five or fewer high reward tags were reported. At such low numbers, estimates of non-reward tag reporting rate can be changed by 25-50% or more by the addition or subtraction of only one reported high-reward tag. This is also true of estimates for some species. For example, if high-reward tags for largemouth bass in 2007 had been reported with one less or one more tag, non-reward tag reporting rate would have changed ± 3%. Nevertheless, for sites with low (<5) returns of high reward tags, exploitation estimates using mean reporting rates for the species of interest were only different by an average of 4%, suggesting the low sample size typically did not result in drastic bias to the resultant exploitation estimates.

Another limitation for our exploitation estimates was that our estimates of tagging mortality were based on limited data. Mortality estimates in the literature for T-bar anchor tags are scarce but include results of 3% for yellow perch over 2-4 d (Scholten et al. 2002) and 11% for crappie over 2 d (Miranda et al. 2002). Often biologists assume tagging mortality is negligible (e.g., Knapp et al. 1991; Shultz and Robinson 2002), and our mean short-term estimate of 1.5% supports this assumption. Considering that tagging mortality in our study was very low and included possible caging stress, the amount of bias due to tagging mortality was likely very low regardless of the actual value.

One of our main concerns with the study design was violating the assumption that tag returns might not be independent, such as if anglers reported batches of tags. The most likely way this could happen is if anglers held onto one or more non-reward tags without reporting them, but if they later caught a reward tag, they might then report the non-reward tags with the reward tag. Another example would be cumulative returns, where anglers might become more likely to report several non-reward tags in their household (saving postage, or time spent on the phone or computer) than they would be for just one non-reward tag. Pollock et al. (2001) suggested the best way to avoid this type of bias is to disperse tags in a large number of

locations so that an angler is not likely to encounter many tags. We spread 27,000 tags across 48 water bodies and 11 species over four years in an attempt to do this. However, when the ultimate goal is to obtain exploitation estimates at a particular water body, a high number of tags must consequently be released in that water body in a given year. For our study, this resulted in substantial angler catch inequality, in that 20% of the people (or households) reported about 43% of the tags. Such catch inequality is common in fisheries (e.g., Smith 1990; Baccante 1995; van Poorten and Post 2005; Michaletz et al. 2008). Fortunately, anglers reporting multiple tags, or those reporting both non-reward and high rewards tags, did not differ statistically (or meaningfully) in their tag reporting rate from anglers reporting only one tag or one type of tag. Based on these findings, we conclude that several hundred tags can likely be released in a particular water body to estimate exploitation without being overly concerned that non-reward reporting rates will be skewed by the presence of a high number of tags or limited numbers of reward tags. Nevertheless, caution should be used to avoid “swamping” anglers with too many tags and risk reducing the average tag reporting rate, which would result in biased exploitation rates if the reduction was not monitored. Henny and Burnham (1976) showed that reporting rates for non-reward duck bands declined in relation to the number of tags in a local area.

Another concern was that having reward tags at liberty in the fisheries might alter angler behavior and lead to inaccurate estimates of exploitation. For example, at Milner Reservoir, some anglers reported that people were fishing because of the reward program. There may also have been some confusion by anglers as to whether or not non-reward tags would result in a reward after the report was made (see Pollock et al. 2001). Initial enthusiasm by anglers for the tagging program may also have elevated reporting rates at the beginning of the study, although we saw no definite pattern of increased or decreased reporting rate over time. We attempted to control for this potential source of bias by not advertising tag releases at any particular water bodies, and instead used statewide education (with informational stickers and posters placed at fishing license venders) to draw attention to the overall program. Thus, we believe this limitation probably had little impact on the results of our study.

A final concern was that the presence of a tag could influence the decision to harvest a fish. We attempted to control for this bias by asking whether anglers harvested the fish only because of the tag, or because they planned to harvest the fish anyway. The fact that anglers released more than 50% of the tagged fish they reported, and that releases were especially high for the most notable catch-and-release fisheries such as largemouth bass and wild trout, suggests that angler harvest was not influenced by the presence of a tag.

Whether managers in the future use the statewide averages for a species or release high-reward tags in a specific water body to obtain site-specific estimates of exploitation depends on the importance of the accuracy and precision of each particular estimate. Our results indicate that there is much variability in tag reporting rates across water bodies, and there will be tradeoffs in terms of estimate accuracy and precision. The confidence bounds using the mean tag reporting rates will usually be smaller than estimating a site-specific tag reporting rate, but because of the variability in reporting rates between sites, the point estimate will likely often be more accurate when site-specific estimates are available via releasing high reward tags with the non-reward tags. In addition, our study occurred in a relatively short time period (i.e., four years), and it is possible that our estimates of tag reporting rate will change over time as anglers become more exposed to tagged fish. Henny and Burnham (1976) found a 10% decline in duck band reporting rate over 16 years, and concluded that hunter curiosity waned over time.

At a minimum, we recommend that at least some high-reward tags be released every year at some water bodies to determine whether tag reporting rates have changed, and to maintain interest in the program. Considering that $50 elicited 92% tag reporting rate, we recommend this dollar value rather than higher values in most cases to maximize value gained from releasing reward tags. Over time, this dollar amount may lose value, and a periodic release of high reward tags (every 5-10 years) should be used to validate the reporting rate of $50 tags.

RECOMMENDATIONS

1. Use results from this study for future IDFG exploitation studies by releasing non-reward T-bar anchor tags and using the estimated tag reporting, tagging mortality, and tag loss rates herein to estimate angler exploitation and to compare hatchery performance or water body performance where fish are stocked.

2. Application of these results to species not included in this study (especially those not similar to any of the species already studied) may be inappropriate and may warrant small-scale replication of this study to estimate tag reporting rates, tag loss, and tagging mortality for the new species in question.

3. Calibration of these non-reward tag reporting rates by releasing $50 tags in some water bodies every year may be necessary to validate that reporting rates have not changed. In addition, releasing high reward tags ($100 or $200) every 5-10 years in a few water bodies should be used to validate that $50 tags are still being reported at an approximate rate of 92%. Such validation should be carried out by IDFG fish management and hatchery staff in the course of routine work, with planning and coordination from research staff.

4. For walleye, yellow perch, smallmouth bass, largemouth bass, and crappie, use current mean reporting rates unless evidence from 2011-2013 hatchery tag returns suggests that reporting rates in Idaho may have changed.

5. Because the Hatchery Trout Evaluation research project is currently releasing a large number of tagged hatchery fish (including reward tags) for ongoing hatchery trout performance studies, regional staff should only release $50 tags (at a ratio of 1:10 with non-reward tags) if they feel a site-specific tag reporting rate may be different than a statewide average reporting rate. If the Hatchery Trout research project ceases to release non-reward and reward tags, management staff and hatchery staff should release $50 reward tags (at the same 1:10 ratio) at several water bodies per year to continue monitoring any changes in angler reporting rates.

ACKNOWLEDGEMENTS

This study would not have been possible without a grant from the U.S. Bureau of Reclamation (BOR) to pay for much of the reward tags. We thank all IDFG personnel who assisted with tagging efforts. Special thanks to Debi Jensen, Kristen Ellsworth, Patrick Kennedy, and Mike Greiner for tagging assistance and data management. Many thanks to Rick Alsager and the Nampa Hatchery crew, and Joe Chapman and the Hagerman Hatchery crew, for their assistance with the hatchery rainbow trout used in this study. Brett Bowersox, Rob Ryan, Melo Maiolie, Dan Schill, and Jeff Dillon provided helpful reviews of the report.

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TABLES

Table 1. Summary of tagged fish released and returned, non-reward tag harvest and reporting rates, and estimates of exploitation and 'use' (i.e., percent of tagged fish caught to date, regardless of harvest or calendar year; see Methods) from 2006 to 2009.

					Tagged fish released						Tagged fish returned						Non-reward tag								
																	1st year	Reporting rate		Site-specific reporting rate		Mean reporting rate		Total
Year	Water body	Species	IDFG region	Origin	$0	$10	$50	$100	$200	Total	$0	$10	$50	$100	$200	Total	fish harvested	Est	90% CI	Est	90% CI	Est	90% CI	rate of "use"
2009	Beaches Pond	Channel Catfish	3N	Wild	31					31	2					2	1					6.1	10.0	12.2
2009	Caldwell Pond #2	Channel Catfish	3N	Wild	75					75	16					16	9					22.7	12.8	40.3
2009	Ed's Pond	Channel Catfish	3N	Wild	23					23	5					5	4					32.8	25.7	41.0
2009	Horseshoe Bend Pond	Channel Catfish	3N	Wild	87					87	6					6	3					6.5	6.3	13.0
2009	McDevitt Pond	Channel Catfish	3N	Wild	39					39	18					18	10					48.4	24.5	87.1
2009	Park Center Pond	Channel Catfish	3N	Wild	70					70	18					18	10					27.0	14.4	48.5
2009	Quinns Pond	Channel Catfish	3N	Wild	43					43	3					3	3					13.2	12.5	13.2
2009	Sawyer's Pond	Channel Catfish	3N	Wild	71					71	7					7	2					5.3	6.2	18.6
2006	Brownlee Reservoir	Crappie	3N	Wild	449	34	40	19	22	564	111	12	15	9	5	152	62	72.4	33.8	20.2	3.9	24.6	4.8	36.2
2007	Brownlee Reservoir	Crappie	3N	Wild	399	42	42	21	21	525	108	10	21	10	10	159	67	56.8	22.8	31.3	5.8	29.9	5.5	50.5
2008	Brownlee Reservoir	Crappie	3N	Wild	379	40	40	20	20	499	73	9	12	10	9	113	48	40.5	17.2	33.1	7.4	22.5	5.0	50.4
2009	Brownlee Reservoir	Crappie	3N	Wild	398	42	42	21	21	524	85	9	15	9	7	125	69	56.1	25.1	32.8	5.9	30.8	5.6	40.4
2006	CJ Strike Reservoir	Crappie	3N	Wild	210	22	16	9	9	266	54	9	6	2	4	75	26	77.1	54.6	17.0	5.2	22.0	6.7	35.4
2007	CJ Strike Reservoir	Crappie	3N	Wild	366	38	38	20	20	482	113	14	12	5	7	151	46	102.9	51.4	13.0	3.0	22.3	5.1	31.8
2008	CJ Strike Reservoir	Crappie	3N	Wild	382	40	40	20	20	502	110	16	21	10	8	165	57	64.0	26.8	24.7	5.0	26.5	5.3	47.8
2009	CJ Strike Reservoir	Crappie	3N	Wild	380	40	40	19	19	498	112	17	20	10	16	175	84	43.1	15.4	54.5	8.7	39.3	6.2	72.6
2006	Mann Lake	Crappie	2	Wild	252	24	24	12	13	325	111	15	16	5	13	160	64	61.2	25.6	44.1	7.9	45.2	8.0	76.4
2009	Anderson Lake	Largemouth Bass	1	Wild	75					75	8					8	0					0.0	-	32.3
2006	Ben Ross Reservoir	Largemouth Bass	3M	Wild	108	12	7	7	9	143	13	2	2	2	3	22	5	38.5	33.3	14.3	9.9	14.0	10.1	37.1
2007	Ben Ross Reservoir	Largemouth Bass	3M	Wild	227	23	25	12	12	299	47	9	12	7	6	81	6	38.2	19.7	8.2	5.2	8.0	5.3	64.3
2009	Blue Lake	Largemouth Bass	1	Wild	137					137	14					14	2					4.4	5.1	30.9
2009	Cave Lake	Largemouth Bass	1	Wild	126					126	19					19	4					9.6	7.8	45.6
2009	Killarney Lake	Largemouth Bass	1	Wild	109					109	6					6	1					2.8	4.6	16.7
2008	Mann Lake	Largemouth Bass	2	Wild	68					68	14					14	10					44.5	21.6	62.3
2009	Medicine Lake	Largemouth Bass	1	Wild	51					51	5					5	3					17.8	16.4	29.7
2006	Pend Oreille River	Largemouth Bass	1	Wild	332	36	37	17	16	438	94	18	24	13	12	161	4	37.4	13.8	3.8	3.0	3.6	3.0	89.9
2008	Spring Valley Reservoir	Largemouth Bass	2	Wild	77					77	12					12	7					27.5	16.4	47.2
2009	Thompson Lake	Largemouth Bass	1	Wild	126					126	19					19	8					19.2	10.9	45.6
2008	Winchester Lake	Largemouth Bass	2	Wild	55					55	15					15	5					27.5	19.4	82.6
2006	Brownlee Reservoir	Smallmouth Bass	3N	Wild	392	33	45	19	19	508	92	15	17	11	11	146	35	40.5	15.8	25.1	6.6	18.6	5.0	66.0
2007	Brownlee Reservoir	Smallmouth Bass	3N	Wild	399	42	42	21	21	525	80	7	10	5	10	112	37	56.1	26.0	18.8	4.8	19.4	5.0	40.7
2008	Brownlee Reservoir	Smallmouth Bass	3N	Wild	382	40	40	20	20	502	109	18	27	8	10	172	57	63.4	26.5	26.8	5.4	31.2	6.3	51.3
2009	Brownlee Reservoir	Smallmouth Bass	3N	Wild	342	36	36	18	18	450	51	8	9	7	7	82	25	38.3	19.0	21.7	6.8	15.3	4.8	44.3
2006	Cascade Reservoir	Smallmouth Bass	3M	Wild	106	2	2	1	1	112	12	0	1	1	0	14	6	22.6	38.8	28.5	18.7	11.8	7.7	57.0
2006	CJ Strike Reservoir	Smallmouth Bass	3N	Wild	292	31	30	15	14	382	90	10	16	8	6	130	29	63.8	30.2	17.7	5.1	20.7	6.0	55.0
2007	CJ Strike Reservoir	Smallmouth Bass	3N	Wild	379	40	40	20	20	499	144	17	22	11	8	202	61	80.0	32.1	22.9	4.4	33.6	6.5	54.1
2008	CJ Strike Reservoir	Smallmouth Bass	3N	Wild	381	40	39	20	20	500	92	10	15	9	10	136	41	50.8	21.1	24.1	5.8	22.5	5.5	54.1
2009	CJ Strike Reservoir	Smallmouth Bass	3N	Wild	381	40	40	21	21	503	104	19	17	13	9	162	61	52.1	20.1	35.0	6.7	33.4	6.5	59.7
2007	Dworshak Reservoir	Smallmouth Bass	2	Wild	383	40	40	20	20	503	96	18	22	12	10	158	40	45.6	17.7	26.1	6.4	21.8	5.4	62.7
2006	Milner Reservoir	Smallmouth Bass	4	Wild	401	40	40	20	20	521	134	18	18	12	10	192	26	60.8	23.0	12.2	3.7	13.5	4.2	62.7

Table 1. Continued.

					Tagged fish released						Tagged fish returned						Non-reward tag								
																		Reporting rate		Annual exploitation using:					Total
			IDFG														Fish			Site-specific reporting rate		Mean reporting rate			rate
Year	Water body	Species	region	Origin	$0	$10	$50	$100	$200	Total	$0	$10	$50	$100	$200	Total	harvested	Est	90% CI	Est	90% CI	Est	90% CI		of "use"
2008	Oakley Reservoir	Walleye	4	Wild	72					72	15					15	10					23.4	11.4		35.1
2009	Oakley Reservoir	Walleye	4	Wild	224	24	24	12	12	296	39	2	9	5	1	56	24	69.6	50.2	16.1	5.9	18.0	5.8		28.7
2007	Salmon Falls Ck. Reservoir	Walleye	4	Wild	559	42	42	21	21	685	123	7	12	7	7	156	45	66.0	30.6	12.7	3.4	13.6	3.3		38.3
2009	Cascade Reservoir	Yellow Perch	3M	Wild	379	40	40	20	20	499	61	7	11	3	8	90	37	58.5	31.5	17.4	4.5	17.4	4.5		28.7
2008	Lake Pend Orielle	Lake Trout	1	Wild	38					38	3					3	1					5.6	9.1		16.9
2009	Lake Pend Orielle	Lake Trout	1	Wild	68					68	6					6	5					15.7	11.2		18.9
2006	Coeur d'Alene River	Rainbow, cutthroat, hybrids	1	Wild	78	9	9	5	5	106	11	0	0	2	2	15	4	35.3	33.9	16.5	13.3	11.0	7.3		45.3
2007	Henry's Lake	Cutthroat trout and hybrids	6	Wild	669	74	73	37	38	891	18	0	5	2	2	27	6	50.4	45.9	2.0	1.4	1.9	1.3		6.0
2009	Little NF Clearwater River	Rainbow, cutthroat, hybrids	2	Wild	123					123	10					10	2					3.5	4.0		17.4
2008	Mann Creek Reservoir	Rainbow Trout	3N	Wild	299					299	39					39	13					9.3	4.2		27.9
2009	Mann Creek Reservoir	Rainbow Trout	3N	Wild	926					926	128					128	92					21.2	3.6		29.6
2006	Moyie River	Rainbow and brook trout	1	Wild	374	25	26	17	12	454	16	3	2	3	0	24	7	41.4	42.8	5.1	3.2	4.0	2.5		11.7
2006	SF Snake River	Rainbow Trout	6	Wild	243	26	27	12	13	321	48	8	7	1	3	67	10	123.5	105.7	3.8	2.1	8.8	4.5		18.1
2007	SF Snake River	Rainbow Trout and hybrids	6	Wild	521	48	48	24	24	665	72	10	13	6	6	107	29	55.3	28.4	11.4	3.5	11.9	3.6		28.3
2009	SF Snake River	Rainbow Trout	6	Wild	422					422	78					78	22					11.2	3.8		39.5
2006	Williams Lake	Rainbow Trout	7	Wild	226	26	25	12	12	301	40	6	5	6	5	62	21	38.6	21.6	27.2	9.5	19.9	6.9		51.9
2007	Williams Lake	Rainbow Trout	7	Wild	228	24	24	12	19	307	20	3	4	2	4	33	10	45.3	34.7	11.0	5.7	9.4	4.8		21.9
2008	Anderson Ranch Reservoir	Rainbow Trout	4	Hagerman Hatchery	303	28	32	15	16	394	6	1	0	0	0	7	5					2.9	2.7		4.5
2008	Anderson Ranch Reservoir	Rainbow Trout	4	Nampa Hatchery	303	32	33	16	16	400	20	1	8	3	3	35	15	35.2	27.0	15.8	7.0	11.3	4.7		15.1
2007	Boise River	Rainbow Trout	3N	Hatchery	380	40	40	20	19	499	89	12	18	11	7	137	45	50.7	21.6	26.2	6.4	27.0	6.2		53.4
2006	Cascade Reservoir	Rainbow Trout	3M	Hagerman Hatchery	378	40	40	20	20	498	18	0	6	3	0	27	15	63.5	65.1	7.0	3.3	9.1	3.8		10.9
2006	Cascade Reservoir	Steelhead	3M	Hagerman Hatchery	377	40	40	20	20	497	9	1	2	1	0	13	3	95.5	165.6	1.9	1.1	1.8	1.7		5.4
2008	Cascade Reservoir	Rainbow Trout	3M	Nampa Hatchery	304	32	32	16	16	400	0	0	1	0	0	1	0					0.0	-		0.0
2008	Cascade Reservoir	Steelhead	3M	Hagerman Hatchery	304	32	32	16	16	400	0	0	0	0	0	0	0					0.0	-		0.0
2006	Chesterfield Reservoir	Rainbow Trout	5	Hatchery	231	24	24	12	13	304	21	1	3	2	3	30	10	45.5	37.2	10.7	5.8	9.9	5.0		20.7
2006	Chesterfield Reservoir	Rainbow Trout (holdovers)	5	Hatchery	147	12	13	8	7	187	17	1	3	1	6	28	7	24.8	18.3	21.6	13.9	10.9	6.6		26.4
2009	Dworshak Reservoir	Rainbow Trout	2	Hatchery	325					325	4					4	3					2.1	2.0		2.8
2007	Glendale Reservoir	Hybrid (RTCT)	5	Hatchery	379	39	40	20	19	497	87	14	17	12	10	140	64	40.7	16.0	46.6	9.3	38.5	7.2		52.4
2009	Kelso Lake	Rainbow Trout	1	Hatchery	197					197	73					73	68					78.8	12.9		84.5
2006	Lake Walcott	Rainbow Trout	4	Hatchery	698	98	100	47	48	991	86	19	19	8	14	146	44	53.2	20.9	13.3	3.4	14.4	3.5		28.1
2007	Little Wood Reservoir	Hybrid (RTCT)	4	Hatchery	378	39	40	20	20	497	6	1	2	1	2	12	5	21.2	24.6	7.0	5.4	3.0	2.2		3.6
2009	Lower Salmon River	Rainbow Trout	7	Hatchery	16					16	1					1	0					0.0	-		14.3
2006	Lucky Peak Reservoir	Rainbow Trout	3N	Hatchery	380	39	38	20	20	497	42	3	6	3	1	55	30	110.5	95.1	8.0	2.8	18.0	5.2		25.2
2007	Mann Creek Reservoir	Rainbow Trout	3N	Hatchery	380	40	41	20	20	501	76	10	18	4	11	119	66	53.3	24.8	36.6	7.2	39.6	7.3		45.6
2006	Mann Lake	Rainbow Trout	2	Hatchery	343	40	40	20	20	463	58	5	7	5	4	79	36	75.2	44.3	15.7	4.4	23.9	6.2		38.6
2007	NF Payette River	Rainbow Trout	3M	Hatchery	670	72	67	36	36	881	53	9	6	8	6	82	31	40.7	20.1	12.8	3.9	10.6	3.0		18.0
2009	Palouse River	Rainbow Trout	2	Hatchery	100					100	2					2	2					4.6	5.3		4.6
2009	Red River	Rainbow Trout	2	Hatchery	100					100	5					5	4					9.1	7.4		11.4
2008	Ririe Reservoir	Cutthroat trout	6	Hatchery	380	40	41	20	20	501	29	5	9	5	3	51	10	38.2	25.1	7.7	4.2	6.0	3.1		17.4
2009	Round Lake	Rainbow Trout	1	Hatchery	198					198	36					36	30					34.6	9.6		41.5
	Total				21703	1802	1816	910	918	27149	3687	409	543	293	299	5231									

Table 2. Summary of reporting method for the number and percent of tag reports received by Idaho Department of Fish and Game from 2006 to 2009 tagging events.

Year	Report Method	$0	$10	$50	$100	$200	Total	Percent
2006	Hotline	706	85	88	60	57	996	62
2006	Mail	13	19	24	8	12	76	5
2006	Regional Office	49	5	12	10	10	86	5
2006	Website	231	33	48	18	20	350	22
2006	Other	86	6	4	4	3	103	6
2007	Hotline	624	68	102	47	51	892	53
2007	Mail	60	15	14	9	10	108	6
2007	Regional Office	41	13	12	5	10	81	5
2007	Website	375	42	57	32	29	535	32
2007	Other	31	3	9	10	6	59	4
2008	Hotline	269	21	42	19	21	372	48
2008	Mail	6	3	9		2	20	3
2008	Regional Office	17	5	7	5	2	36	5
2008	Website	241	29	34	20	17	341	44
2008	Other	4	2	1	1	1	9	1
2009	Hotline	496	25	29	17	22	589	48
2009	Mail	16	4	3	1	2	26	2
2009	Regional Office	39	8	8	3	2	60	5
2009	Website	436	24	40	26	21	547	44
2009	Other	11	1	1	0	1	14	1

Table 3. Number of fish initially tagged (*N*) and reported (*R*), and percent returned by reward value, as well as the estimated reporting rates (%) and confidence intervals for all species from 2006 to 2009 (assuming that $200 elicited a 100% reporting rate; see Methods). Table includes only instances where reward and non-reward tags were released concurrently in a particular water body.

																	Reporting rates									
		$0			$10			$50			$100			$200			$0[a]		$0[b]		$10		$50		$100	
Species	Year	*N*	*R*	%	*N*	*R*	%	*N*	*R*	%	*N*	*R*	%	*N*	*R*	%	Estimate	90% CI	Estimate	90% CI	Estimate	90% CI	Estimate	90% CI	Estimate	90% CI
Crappie	2006	911	276	30.3	80	36	45.0	80	37	46.3	40	16	40.0	44	22	50.0	60.6	6.0	67.0	6.7	90.0	10.5	92.5	25.3	80.0	33.2
	2007	765	221	28.9	80	24	30.0	80	33	41.3	41	15	36.6	41	17	41.5	69.7	7.8	74.0	8.2	72.4	9.0	99.5	28.8	88.2	37.9
	2008	761	183	24.0	80	25	31.3	80	33	41.3	40	20	50.0	40	17	42.5	56.6	6.9	52.0	6.3	73.5	11.1	97.1	28.1	117.6	43.9
	2009	778	197	25.3	82	26	31.7	82	35	42.7	40	19	47.5	40	23	57.5	44.0	5.2	48.2	5.7	55.1	7.3	74.2	20.8	82.6	31.5
	Total	3,215	877	27.3	322	111	34.5	322	138	42.9	161	70	43.5	165	79	47.9	57.0	3.2	59.7	3.3	72.0	4.3	89.5	12.6	90.8	17.9
Smallmouth bass	2006	1,227	336	27.4	112	45	40.2	122	53	43.4	58	34	58.6	59	27	45.8	59.8	5.4	52.5	4.7	87.8	9.6	94.9	21.6	128.1	36.5
	2007	1,161	320	27.6	122	42	34.4	122	54	44.3	61	28	45.9	61	28	45.9	60.0	5.5	60.0	5.5	75.0	7.9	96.4	21.8	100.0	31.3
	2008	763	201	26.3	80	28	35.0	79	42	53.2	40	17	42.5	40	20	50.0	52.7	6.2	57.0	6.6	70.0	9.5	106.3	27.3	85.0	34.3
	2009	723	155	21.4	76	27	35.5	76	26	34.2	39	20	51.3	39	16	41.0	52.3	7.0	46.4	6.2	86.6	16.2	83.4	27.2	125.0	46.7
	Total	3,874	1,012	26.1	390	142	36.4	399	175	43.9	198	99	50.0	199	91	45.7	57.1	3.0	54.6	2.8	79.6	4.6	95.9	12.0	109.3	18.1
Largemouth bass	2006	440	107	24.3	48	20	41.7	44	26	59.1	24	15	62.5	25	15	60.0	40.5	6.5	39.7	6.3	69.4	14.8	98.5	32.4	104.2	45.2
	2007	227	47	20.7	23	9	39.1	25	12	48.0	12	7	58.3	12	6	50.0	41.4	10.1	38.2	9.2	78.3	31.8	96.0	47.4	116.7	76.0
	Total	667	154	23.1	71	29	40.8	69	38	55.1	36	22	61.1	37	21	56.8	40.7	5.4	39.2	5.2	72.0	12.7	97.0	26.2	107.7	38.3
Hatchery trout	2006	2,554	251	9.8	293	30	10.2	295	46	15.6	147	23	15.6	148	28	18.9	51.9	5.4	56.8	5.9	54.1	7.0	82.4	20.0	82.7	28.4
	2007	2,187	311	14.2	230	46	20.0	228	61	26.8	116	36	31.0	114	36	31.6	45.0	4.2	45.4	4.2	63.3	7.4	84.7	17.9	98.3	27.1
	2008	1,594	55	3.5	164	7	4.3	170	18	10.6	83	8	9.6	84	6	7.1	48.3	10.7	41.2	9.1	59.8	34.0	148.2	58.0	134.9	79.1
	Total	6,335	617	9.7	687	83	12.1	693	125	18.0	346	67	19.4	346	70	20.2	48.1	3.2	49.2	3.3	59.7	4.8	89.2	13.1	95.7	19.3
Wild trout	2006	921	115	12.5	86	17	19.8	87	14	16.1	46	12	26.1	42	10	23.8	52.4	8.1	49.9	7.7	83.0	20.9	67.6	30.0	109.6	52.7
	2007	1,418	110	7.8	146	13	8.9	145	22	15.2	73	10	13.7	81	12	14.8	52.4	8.2	54.3	8.5	60.1	14.4	102.4	36.1	92.5	48.4
	Total	2,339	225	9.6	232	30	12.9	232	36	15.5	119	22	18.5	123	22	17.9	53.8	5.9	52.9	5.8	72.3	11.6	86.8	23.9	103.4	36.4
Walleye	2007	559	123	22.0	42	7	16.7	42	12	28.6	21	7	33.3	21	7	33.3	66.0	9.9	66.0	9.9	50.0	8.3	85.7	41.5	100.0	63.6
	2009	224	39	17.4	24	2	8.3	24	9	37.5	12	5	41.7	12	1	8.3	208.9	59.6	69.6	18.6	100.0	47.1	450.0	289.3	500.0	437.8
	Total	783	162	20.7	66	9	13.6	66	21	31.8	33	12	36.4	33	8	24.2	85.3	11.2	68.3	8.9	56.3	8.3	131.3	48.0	150.0	72.8
Yellow perch	2009	379	61	16.1	40	7	17.5	40	11	27.5	20	3	15.0	20	8	40.0	40.2	8.6	58.5	12.4	43.8	11.0	68.8	34.7	37.5	35.9
Grand total		17,592	3,108	17.7	1,808	411	22.7	1,821	544	29.9	913	295	32.3	923	299	32.4	54.5	1.6	54.6	1.6	70.2	2.2	92.2	6.5	99.7	9.6

[a]Based only on $200 tags as high rewards.

[b]Based on using $100 and $200 tags as high rewards.

Table 4. Estimates of tag loss within one and two years of tagging for all species. Weighted means are reported.

	Total number of double tagged fish reported in:		Percent tag loss											
			Year one returns from tags released in:						Year two returns from tags released in:					
							Combined						Combined	
Species	Year one	Year two[a]	2006	2007	2008	2009	Mean	90% CI	2006	2007	2008	2009[b]	Mean	90% CI
Crappie	685	131	4.7	2.5	1.6	2.4	2.8	1.1	9.6	3.7	0.0		4.6	3.1
Hatchery trout	503	29	12.4	6.1	12.0		8.2	2.0	33.3	22.7	16.7		22.4	13.0
Wild trout	163	63	11.2	6.3		16.7	8.9	3.8	10.8	16.7			12.7	7.0
Largemouth bass	122	36	11.4	16.3			13.1	5.1	25.0	21.9			23.6	11.9
Smallmouth bass	1,030	30	11.2	9.5	9.2	7.3	9.6	1.5	25.0	36.7	33.3		31.7	14.3
Walleye	97	38		10.2			10.3	5.2		32.9			32.9	12.8
Yellow perch	42					1.2	1.2	2.9					[b]	
Holdover hatchery trout	12	5	4.2				4.2	9.7	10.0				10.0	22.5

[a] Does not include 2010 data

[b] Estimates not yet available

Table 5. Estimates of short-term mortality for tagged and untagged fish held in cages to estimate tagging mortality.

			Tagged fish					Untagged fish				
			Fish length (mm)			Percent mortality		Fish length (mm)			Percent mortality	
Water body	Species	Origin	*n*	Mean	Range	1 day	7 day	*n*	Mean	Range	1 day	7 day
Brownlee Reservoir	Crappie	Wild	20	193	185-225	0	5	20	193	180-215	0	0
Brownlee Reservoir	Crappie	Wild	20	217	200-228	0	0[a]	20	213	200-228	0	0[a]
Brownlee Reservoir	Smallmouth bass	Wild	14	395	205-465	0	0	14	381	310-470	0	0
Brownlee Reservoir	Smallmouth bass	Wild	20	418	308-518	0	0[a]	20	390	306-475	0	0[a]
CJ Strike Reservoir	Crappie	Wild	40	200	190-239	-	7.5[a]	40	199	195-215	-	5[a]
CJ Strike Reservoir	Smallmouth bass	Wild	15	318	305-347	6.7	6.7	15	329	306-395	0	6.7
SF Snake River	Rainbow trout	Wild	20	477	380-605	-	0	20	459	368-520	-	0
SF Boise River	Rainbow trout	Wild	20	425	320-570	0	0	20	449	285-583	0	0
Lake Lowell	Largemouth bass	Wild	16	344	308-388	0	0	15	353	305-419	0	0
Ririe Reservoir	Cutthroat trout	Mackay Hatchery	500	285	-	0	-					
Hatchery	Rainbow trout	Grace Hatchery	500	280	-	0	1.0[b]					
Hatchery	Rainbow trout	American Falls Hatchery	500	250	-	0	0.4[b]					
Hatchery	Rainbow trout	Nampa Hatchery	500	260	-	0	1.8[b]					
Hatchery	Rainbow trout	Nampa Hatchery	100	240	-	0	0[b]					

[a]Sampled 8 days after release

[b]Held in hatchery 22-33 days.

Table 6. Mean and range of annual exploitation and total ‘use’ estimates by species.

		Annual exploitation (%)		Total 'use' (%)	
Species	*n*	Mean	Range	Mean	Range
Channel catfish	8	20.2	5.3 - 48.4	34.2	12.2 - 87.1
Crappie	9	30.1	13.0 - 54.5	49.1	31.8 - 76.4
Lake trout	2	10.7	5.6 - 15.7	17.9	16.6 - 18.9
Smallmouth bass	11	23.6	12.2 - 35.0	55.3	40.7 - 66.0
Largemouth bass	12	15.0	0.0 - 44.5	48.7	16.7 - 89.9
Hatchery trout	23	15.7	0.0 - 78.7	22.8	0.0 - 84.5
Wild trout	11	11.1	2.0 - 27.2	27.1	6.0 - 51.9
Walleye	3	18.3	14.0 - 23.4	34	28.7 - 38.3

FIGURES

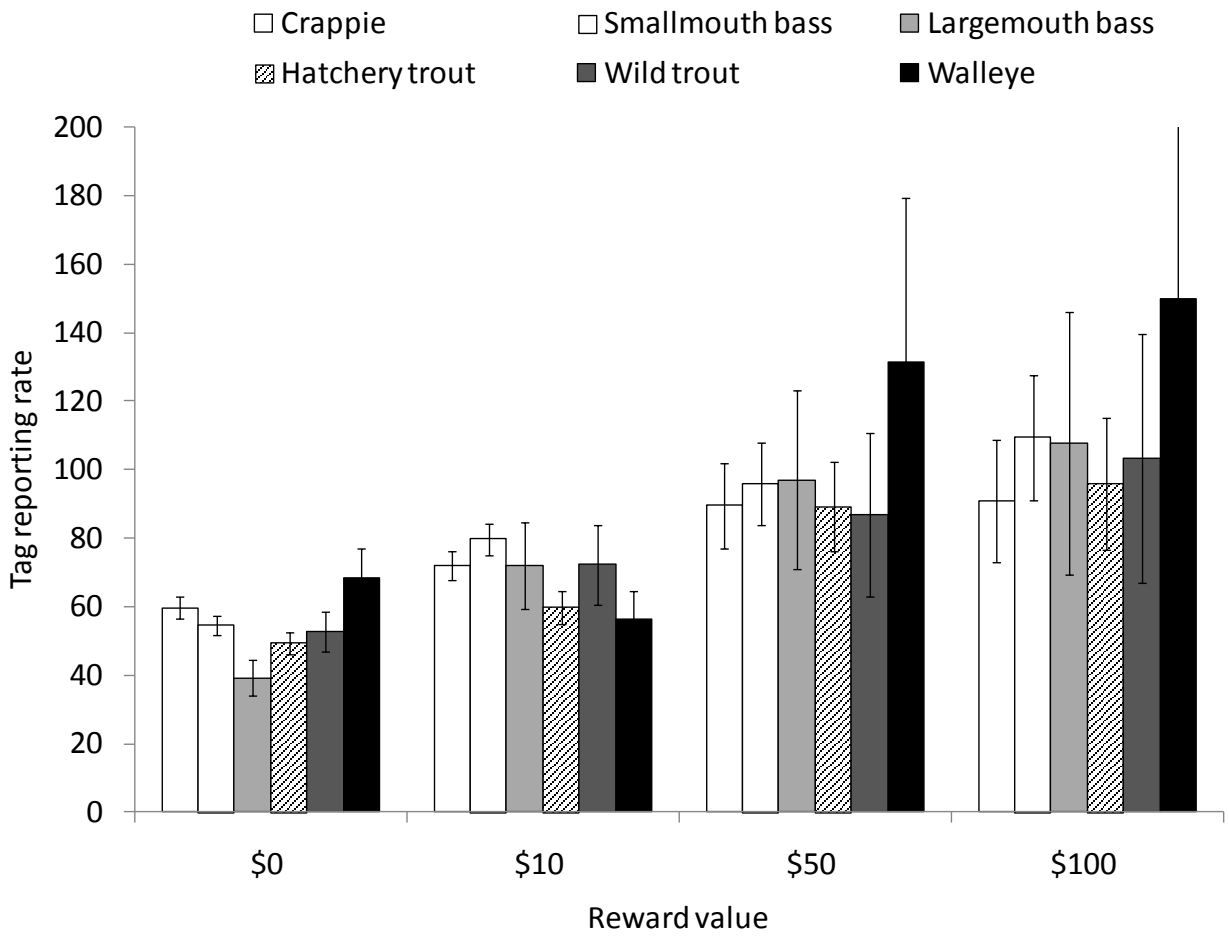

Figure 1. Tab reporting rate (and 90% confidence intervals) for various species by reward value for fish released with anchor tags and reported by anglers in Idaho.

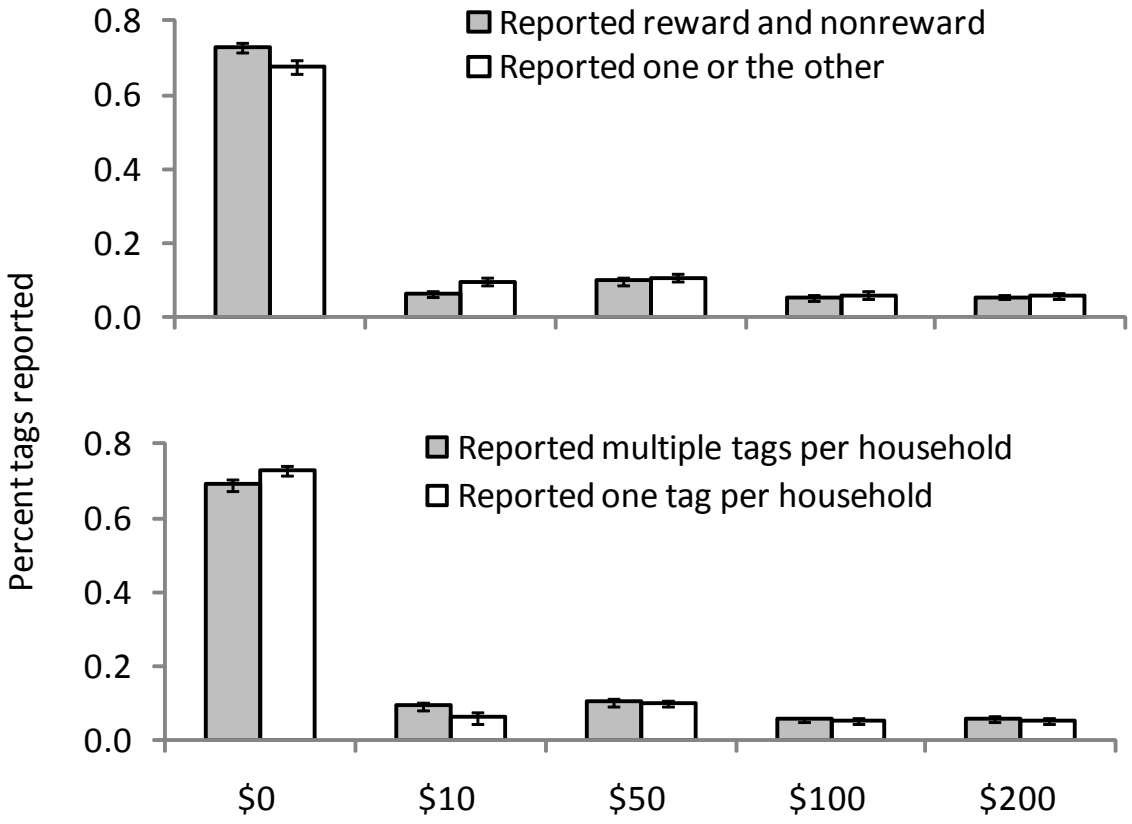

Figure 2. Percentage of tags reported (and 90% confidence intervals) by dollar amount for anglers who reported both reward and non-reward tags compared to one or the other, or who reported one tag only from a given household compared to multiple tags from the same household.

Prepared by:

Kevin A. Meyer
Principal Fisheries Research Biologist

Arthur E. Butts
Regional Fisheries Biologist

F. Steven Elle
Senior Fisheries Technician

James A. Lamansky, Jr.
Senior Fisheries Research Biologist

Elizabeth R. J. M. Mamer
Data Coordinator

Approved by:

IDAHO DEPARTMENT OF FISH AND GAME

_____
Daniel J. Schill
Fisheries Research Manager

_____
Edward B. Schriever, Chief
Bureau of Fisheries